

**SECTION 03 30 00 – CAST-IN-PLACE CONCRETE**

**PART 1 - GENERAL**

**1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

**1.2 SUMMARY**

- A. Extent of concrete work is shown on drawings.
- B. Concrete paving and walks are specified in Division 2.

**1.3 SUBMITTALS**

- A. Product Data: Submit data for proprietary materials and items, including reinforcement and forming accessories, admixtures, patching compounds and others as required by Architect.
- B. Samples: Submit samples of materials as requested by Architect, including names, sources and descriptions.
- C. Laboratory Test Reports: Submit laboratory test reports for concrete materials and mix design test.
- D. Materials Certificates: Provide materials certificates in lieu of materials laboratory test reports when permitted by Architect. Materials certificates shall be signed by manufacturer and Contractor, certifying that each material item complies with, or exceeds, specified requirements. Provide certification from admixture manufacturers that chloride content complies with specification requirements.
- E. Shop Drawings: Reinforcement: Submit shop drawings for fabrication, bending and placement of concrete reinforcement. Comply with ACI 315 "Manual of Standard Practice for Detailing Reinforced Concrete Structures" showing bar schedules, stirrup spacing diagrams of bent bars, arrangement of concrete reinforcement.
- F. LEED Submittals:
  - 1. Product Data for Credit MR 4.1: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content.
    - a. Include statement indicating costs for each product having recycled content.
  - 2. Design Mixtures for Credit ID 1.1: For each concrete mixture containing slag as a replacement for portland cement or other portland cement replacements and for

equivalent concrete mixtures that do not contain portland cement replacements.

**1.4 QUALITY ASSURANCE**

- A. Codes and Standards: Comply with provisions of following codes, specifications and standards, except where more stringent requirements are shown or specified:
  - 1. ACI 301 "Specifications for Structural Concrete for Buildings".
  - 2. ACI 318 "Building Code Requirements for Reinforced Concrete".
  - 3. Concrete Reinforcing Steel Institute (CRSI), "Manual of Standard Practice".
- B. Concrete Testing Service: Engage a testing laboratory acceptable to Architect to perform material evaluation tests and to design concrete mixes.
- C. Materials and installed work may require testing and retesting at anytime during progress of work. Tests, including retesting of rejected materials for installed work, shall be done at Contractor's expense.
- D. Preinstallation Conference: Conduct conference at a Project site to comply with requirements in Division 01 Section "Project Management and Coordination".
  - 1. Before submitting design mixtures, review concrete design mixture and examine procedures for ensuring quality of concrete materials. Require representatives of each entity directly concerned with cast-in-place concrete to attend, including the following:
    - a. Contractor's superintendent.
    - b. Independent testing agency responsible for concrete design mixtures.
    - c. Ready-mix concrete manufacturer.
    - d. Concrete subcontractor.
      - i. Review special inspection and testing and inspecting agency procedures for field quality control, concrete finishes and finishing, cold and hot weather concreting procedures, curing procedures, construction contraction and isolation joints and joint filler strips, semirigid joint fillers, forms and form removal limitations, vapor retarder installation, anchor rod and anchorage device installation tolerances, steel reinforcement installation, floor and slab flatness and levelness measurement, concrete repair procedures and concrete protection.
      - ii. Specifically review curing and finishing procedure affected by LEED slag requirement that may retard the curing of the concrete and the timing of final finish installation.

**PART 2 - PRODUCTS**

**2.1 FORM MATERIALS**

- A. Forms for Exposed Finish Concrete: Plywood, metal, metal-framed plywood faced, or other acceptable panel-type materials, to provide continuous, straight, smooth, exposed surfaces. Furnish in largest practicable sizes to minimize number of joints and to conform to joint system shown on drawings.
- B. Forms for Unexposed Finish Concrete: Plywood, lumber, metal, or other acceptable material. Provide lumber dressed on at least 2 edges and one side for tight fit.
- C. Form Coatings: Provide commercial formulation form-coating compounds that will not bond with, stain, nor adversely affect concrete surfaces, and will not impair subsequent treatments of concrete surfaces.

## 2.2 REINFORCING MATERIALS

- A. Reinforcing Bars: ASTM A 615, Grade 60, deformed.
- B. Steel Wire: ASTM A 82, plain, cold-drawn steel.
- C. Welded Wire Fabric: ASTM A 185, welded steel wire fabric.
- D. Welded Deformed Steel Wire Fabric: ASTM A 497.
- E. Supports for Reinforcement: Bolsters, chairs, spacers and other devices for spacing, supporting and fastening reinforcing bars and welded wire fabric in place. Use wire bar type supports complying with CRSI specifications.

## 2.3 CONCRETE MATERIALS

- A. Portland Cement: ASTM C 150, Type I or Type II.
  - 1. Use one brand of cement throughout project, unless otherwise acceptable to Architect.
- B. Normal Weight Aggregates: ASTM C 33, and as herein specified. Provide aggregates from a single source for exposed concrete.
- C. Water: Drinkable.
- D. Air-Entraining Admixture: ASTM C 260, certified by manufacturer to be compatible with other required admixtures.
  - 1. Products: Subject to compliance with requirements, provide one of the following:
    - "Air-Mix"; Euclid Chemical Co.
    - "Sika Aer"; Sika Corp.
    - "MB-VR or MB-AE"; Master Builders.
    - "Darex AEA" or "Daravair"; W.R. Grace.

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- E. Water-Reducing Admixture: ASTM C 494, Type A, and containing not more than 0.05 percent chloride ions.
1. Products: Subject to compliance with requirements, provide one of the following:  
  
"WRDA" Hycol"; W.R.Grace.  
"Eucon WR-75" or "Eucon WR-89"; Euclid Chemical Co.  
"Pozzolith 322N"; Master Builders.
- F. High-Range Water-Reducing Admixture (Super Plasticizer) ASTM C 494, Type F or Type G and containing not more than 0.05 percent chloride ions.
1. Products: Subject to compliance with requirements, provide one of the following:  
  
"Daracem 100" or "WRDA-19"; W.R. Grace.  
"Eucon 37"; Euclid Chemical Co.  
"Rheobuild 1000"; Master Builders.  
"Sika 86"; Sika Corporation.
- G. Water-Reducing, Non-Chloride Accelerator Admixture: ASTM C 494, Type E, and containing not more than 0.024 percent chloride ions.
1. Products: Subject to compliance with requirements, provide one of the following:  
  
"Pozzolith 20"; Master Builders.  
"Accelguard 80"; Euclid Chemical Co.  
"Daraset"; W.R. Grace  
or approved equal
- H. Water-Reducing, Retarding Admixture: ASTM C 494, Type D and containing not more than 0.05 percent chloride ions.
1. Products: Subject to compliance with requirements, provide one of the following:  
  
"Pozzolith Retarder"; Master Builders.  
"Eucon Retarder 75"; Euclid Chemical Co.  
"Daratard 17"; W.R. Grace.  
"Plastocrete 161R"; Sika Corporation.  
or approved equal
- I. Prohibited Admixtures: Calcium chloride thycyanates or admixtures containing more than 0.05 percent chloride ions are not permitted.

2.4 RELATED MATERIALS

- A. Extruded Polystyrene Board Insulation: Rigid closed-cell extruded, expanded

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polystyrene insulation board with integral high-density skin, complying with ASTM C-578 Type IV: min. 25 psi compressive strength ASTM D 1621: k value of 0.20 ASTM C 518: 0.30% maximum water absorption ASTM C272: 1.1 perm/inch max water vapor transmission: manufacturer's standard length and widths.

1. Manufacturer: Subject to compliance with requirements, provide products of one of the following or an approved equal:
  - (a) Dow Chemical Co: Midland MI
  - (b) VC Industries/V.5 Gypsum: Chicago, IL.
  
- B. Non-Shrink Grout: CRD-C 621, factory pre-mixed grout.
  1. Available Products: Subject to compliance with requirements, products which may be incorporated in the work include, but are not limited to, the following:
  2. Products: Subject to compliance with requirements provide one of the following:
  3. Non-metallic
    - "Masterflow 713"; Master Builders
    - "Euco-NS"; Euclid Chemical Co.
    - "Five Star Grout"; U.S. Grout Corporation.
    - or approved equal
  
- C. Absorptive Cover: Burlap cloth made from jute or kenaf weighing approximately 9 oz. per sq. yd., complying with AASHTO M 182, Class 2.
  
- D. Moisture-Retaining Cover: One of the following, complying with ASTM C 171.
  1. Waterproof paper.
  2. Polyethylene film.
  3. Polyethylene-coated burlap.
  
- E. Clear curing and sealing compound (VOC Compliant): The compound shall have 30% solids content minimum, and will not yellow under ultra violet light after 500 hours of test in accordance with ASTM D4887 and will have test data from an independent testing laboratory indicating a maximum moisture loss of 0.039 grams per sq. cm. when applied at a rate of 300 sq. ft. per gallon. Sodium silicate compounds are not permitted.
  1. Subject to compliance with requirements, products which may be incorporated in the work include one of the following:
    - "Super Diamond Clear Vox" by Euclid Chemical Co.
    - "Dress and Seal 18" by L&M Construction Chemicals, Inc.
    - "Kure-N-Seal 0800 VOC" by Sonneborn
    - or approved equal.

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- F. Moisture Barrier/Water Vapor Retarder: Provide moisture barrier cover over prepared base material where indicated below slabs on grade. Use only materials which are resistant to decay when tested in accordance with the following:
1. Thickness: 15 mils
  2. Permeance: less than 0.01 perms (grain/ft<sup>2</sup>/hr/in-Hg) as tested after mandatory conditioning (ASTM E 1745. Paragraphs 7.1.2.5).
  3. Puncture resistance: ASTM D 1709; 2200 grams
  4. Chemical Resistance: ASTM E 154, indefinite
  5. Life Expectancy: ASTM E 154, indefinite
  6. Subject to compliance with requirements, product which may be incorporated in the work include one of the following:
    - a. "Wrap 15-mil" Vapor Barrier by Stego Industries LLC
    - b. "Premoulded Membrane" W.R. Meadows.
    - c. "Griffelyn VaporGuard" by Reef Industries.
    - d. or approved equal
  7. Accessories: Seam tape; ASTM E 96, 0.3 perms or lower
  8. Moisture barrier sheets with seams overlapped not less than 12"
  9. Installation shall be in accordance with manufacturer's direction and in compliance with ASTM E 1643-09 "Standard Practice for Selection, Design, Installation and Inspection of Water Vapor Retarders Used in Contact with Earth or Granular Fill Under Concrete Slabs".
- G. Joint Filler Strips: ASTM D 1752, cork or self-expanding cork.

2.5 PROPORTIONING AND DESIGN OF MIXES

- A. Prepare design mixes for each type and strength of concrete by either laboratory trial batch or field experience methods as specified in ACI 301. If trial batch method used, use an independent testing facility acceptable to Architect for preparing and reporting proposed mix designs. The testing facility shall not be the same as used for field quality control testing.
- B. Submit written reports to Architect and Structural Engineer of each proposed mix for each class of concrete at least 15 days prior to start of work. Do not begin concrete production until mixes have been reviewed by Architect.
- C. Design mixes to provide normal weight concrete with the following properties, as indicated on drawings and schedules:
- D. 3000 psi 28-day compressive strength; W/C ratio, 0.51 maximum, 3500 psi 28-day compressive strength W/C ratio, 0.47 maximum.
- E. Adjustment to Concrete Mixes: Mix design adjustments may be requested by Contractor when characteristics of materials, job conditions, weather, test results or other circumstances warrant; at no additional cost to Owner and as accepted by Architect. Laboratory test data for revised mix design and strength results must be admitted to and accepted by Architect before using in work.
- F. Admixtures:

1. Use water-reducing admixture or high range water-reducing admixture (super plasticizer) in concrete as required for placement and workability.
  2. Use high-range water-reducing admixture in pumped concrete, concrete for industrial slabs, architectural concrete, parking structure slabs, concrete required to be watertight and concrete with water/cement ratios below 0.50.
  3. Use admixtures for water-reducing and set-control in strict compliance with manufacturer's directions.
  4. Use air-entraining admixture in exterior exposed concrete, unless otherwise indicated. Add air-entraining admixture at manufacturer's prescribed rate to result in concrete at point of placement having air content within following limits.
    - (a) 5% for maximum 2" aggregate
    - (b) 6% for maximum 3/4" aggregate
    - (c) 7% for maximum 1/2" aggregate
- G. Slump Limits: Proportion and design mixes to result in concrete slump at point of placement as follows:
1. Ramps, slabs and sloping surfaces: Not more than 3".
  2. Reinforced foundation systems: Not less than 1" and not more than 3".
  3. Concrete containing HRWR admixture (super-plasticizer): Not more than 8" after addition of HRWR to site-verified 2"-3" slump concrete.
  4. Other concrete: Not less than 1" nor more than 4"

## 2.6 CONCRETE MIXING

- A. Ready-Mix Concrete: Comply with requirements of ASTM C94, and as herein specified.
- B. During hot weather, or under conditions contributing to rapid setting of concrete, a shorter mixing time than specified in ASTM C 94 may be required.

## PART 3 - EXECUTION

### 3.1 FORMS

- A. Design, erect, support, brace and maintain formwork to support vertical and lateral loads that might be applied until such loads can be supported by concrete structure. Construct formwork so concrete members and structure are of correct size, shape, alignment, elevations and position.
- B. Construct forms to sizes, shapes, lines and dimensions shown, and to obtain accurate alignment, location, grades, level and plumb work in finished structures. Provide for

openings, offsets, sinkages, keywarp, recesses, moldings, rustications, reglets, chamfers, blocking, screeds, bulkheads, anchorages and inserts, and other features, required in work. Use selected materials to obtain required finishes. Solidly butt joints and provide back-up at joints to prevent leakage of cement paste.

### 3.2 PLACING REINFORCEMENT

- A. Comply with Concrete Reinforcing Steel Institute's recommended practice for "Placing Reinforcing Bars", for details and methods of reinforcement placement and supports, and as herein specified.
  - 1. Avoiding cutting or puncturing vapor retarder during reinforcement placement and concreting operations.
- B. Clean reinforcement of loose rust and mill scale, earth, ice and other materials which reduce or destroy bond with concrete.
- C. Accurately position, support and secure reinforcement against displacement by formwork, construction, or concrete placement operations. Locate and support reinforcing by metal chairs, runners, bolsters, spacers and hangers, as required.
- D. Place reinforcement to obtain at least minimum coverages for concrete protection. Arrange, space and securely tie bars and bar supports to hold reinforcement in position during concrete placement operations. Set wire ties so ends are directed into concrete, not toward exposed concrete surfaces.
- E. Install welded wire fabric in as long lengths as practicable. Lap adjoining pieces at least one full mesh and lace splices with wire. Offset end laps in adjacent widths to prevent continuous laps in either direction.

### 3.3 JOINTS

- A. Construction Joints: Locate and install construction joints as indicated or, if not indicated, locate at a maximum spacing of 90 feet, so as not to impair strength and appearance of the structure, as acceptable to Architect.
- B. Control Joints: Locate and install control joints as indicated or at a maximum spacing of 30 feet. Locate at a spacing which does not impair appearance of the structure as acceptable to Architect.
- C. Joint filler and sealant materials are specified in Division-7 sections of these specifications.

### 3.4 INSTALLATION OF EMBEDDED ITEMS

- A. General: Set and build into work anchorage devices and other embedded items required for other work that is attached to, or supported by, cast-in-place concrete. Use setting drawings, diagrams, instructions and directions provided by suppliers of items to be attached thereto.

- B. Edge Forms and Screed Strips for Slabs: Set edge forms, or bulkheads and intermediate screed strips for slabs to obtain required elevations and contours in finished slab surface. Provide and secure units sufficiently strong to support types of screed strips by use of strike-off templates or accepted compacting type screeds.

### 3.5 CONCRETE PLACEMENT

- A. Preplacement inspection: Before placing concrete, inspect and complete formwork installation, reinforcing steel and items to be embedded or cast-in. Notify other crafts to permit installation of their work; cooperate with other trades in setting such work. Moisten wood forms immediately before placing concrete where form coatings are not used.
  - 1. Apply temporary protective covering to lower 2' of finished walls adjacent to poured floor slabs and similar conditions, and guard against spattering during placement.
- B. General: Comply with ACI 304R "Guide for Measuring, Mixing, Transporting and Placing Concrete", and as herein specified.
- C. Deposit concrete continuously or in layers of such thickness that no concrete will be placed on concrete which has hardened sufficiently to cause the formation of seams or planes of weakness. If a section cannot be placed continuously, provide construction joints as herein specified. Deposit concrete as nearly as practicable to its final location to avoid segregation.
- D. Placing Concrete Slabs: Deposit and consolidate concrete slabs in a continuous operation, within limits of construction joints, until the placing of a panel or section is completed.
- E. Consolidate concrete during placing operations so that concrete is thoroughly worked around reinforcement and other embedded items and into corners.
- F. Bring slab surfaces to correct level with straightedge and strikeoff. Use bull floats or darbies to smooth surface, free of humps or hollows. Do not disturb slab surfaces prior to beginning finishing operations.
- G. Maintain reinforcing in proper position during concrete placement operations.
- H. Cold Weather Placing: Protect concrete work from physical damage or reduced strength which would be caused by frost, freezing actions or low temperatures, in compliance with ACI 306R.
- I. Do not use calcium chloride, salt and other materials containing antifreeze agents or chemical accelerators, unless otherwise accepted in mix designs.
- J. Hot Weather Placing: When hot weather conditions exist that would seriously impair quality and strength of concrete, place concrete in compliance with ACI 305R.

**3.6 MONOLITHIC SLAB FINISHES**

- A. Float Finish: Apply float finish to monolithic slab surfaces to receive trowel finish and other finishes as hereinafter specified, and slab surfaces which are to be covered with membrane or elastic waterproofing, membrane or elastic roofing, or sand-bed terrazzo, and as otherwise indicated.
- B. After screeding, consolidating and leveling concrete slabs, do not work surface until ready for floating. Begin floating when surface water has disappeared or when concrete has stiffened sufficiently to permit operation of power-driven floats, or both. Consolidate surface with power-driven floats, or by hand-floating if area is small or inaccessible to power units. Check and level surface plane to tolerances of Ff18 - Ff15. Cut down high spots and fill low spots. Uniformly slope surfaces to drains. Immediately after leveling, refloat surface to a uniform, smooth, granular texture.
- C. Trowel Finish: Apply trowel finish to monolithic slab surfaces to be exposed-to-view, and slab surfaces to be covered with resilient flooring, carpet, ceramic or quarry tile, paint, or other thin film finish coating system.
- D. After floating, begin first trowel finish operation using a power driven trowel. Begin final troweling when surface produces a ringing sound as trowel is moved over surface. Consolidate concrete surface by final hand-troweling operation, free of trowel marks, uniform in texture and appearance, and with surface leveled to tolerances of Ff20 - Ff17. Grind smooth surface defects which would telegraph through supplied floor covering system.
- E. Non-Slip Broom Finish: Apply non-slip broom finish to exterior concrete platforms, steps and ramps and elsewhere as indicated.

**3.7 CONCRETE CURING AND PROTECTION**

- A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures.
- B. Start initial curing as soon as free water has disappeared from concrete surface after placing and finishing. Weather permitting, keep continuously moist for not less than 7 days.
- C. Begin final curing procedures immediately following initial curing and before concrete has dried. Continue final curing for at least 7 days in accordance with ACI 301 procedures. Avoid rapid drying at end of final curing period.
- D. Curing Methods: Perform curing of concrete by curing and sealing compound, by moist curing, by moisture-retaining cover curing and by combinations thereof, as herein specified.
- E. Provide moisture curing by following methods.
  - 1. Keep concrete surface continuously wet by covering with water.

2. Continuous water-fog spray.
  3. Covering concrete surface with specified absorptive cover, thoroughly saturating cover with water and keeping continuously wet. Place absorptive cover to provide coverage of concrete surfaces and edges, with 4" lap over adjacent absorptive covers.
- F. Provide moisture-cover curing as follows:
1. Cover concrete surfaces with moisture-retaining cover for curing concrete, place in widest practicable width with sides and ends lapped at least 3" and sealed by waterproof tape or adhesive. Immediately repair any holes or tears during curing period using cover material and waterproof tape.
- G. Do not use membrane curing compounds on surfaces which are to be covered with coating material applied directly to concrete, liquid floor hardener, waterproofing, dampproofing, membrane roofing, flooring (such as ceramic or quarry tile, glue-down carpet), painting and other coatings and finish materials, unless otherwise acceptable to Architect.
- H. Curing Unformed Surfaces: Cure unformed surfaces, such as slabs, floor topping, and other flat surfaces by application of appropriate curing method.
- I. Final cure concrete surfaces to receive liquid floor hardener or finish flooring by use of moisture retaining cover, unless otherwise directed.
- 3.8 MISCELLANEOUS CONCRETE ITEMS
- A. Equipment Bases and Foundations: Provide machine and equipment bases and foundations, as shown on drawings. Set anchor bolts for machines and equipment to template at correct elevations, complying with certified diagrams or templates of manufacturer furnishing machines and equipment.
  - B. Grout base plates and foundations as indicated, using specified non-shrink grout. Use non-metallic grout for exposed conditions, unless otherwise indicated.
- 3.9 CONCRETE SURFACE REPAIRS
- A. Repair of Unformed Surfaces: Test unformed surfaces, such as monolithic slabs, for smoothness and verify surface plane to tolerances specified for each surface and finish. Correct low and high areas as herein specified. Test unformed surfaces sloped to drain for trueness of slope, in addition to smoothness using a template having required slope.
  - B. Repair finished unformed surfaces that contain defects which affect durability of concrete. Surface defects, as such, include crazing, cracks in excess of 0.01" wide or which penetrate to reinforcement or completely through non-reinforced sections regardless of width, spalling, pop-outs, honeycomb, rock pockets and other objectionable conditions.
  - C. Correct high areas in unformed surfaces by grinding, after concrete has cured at least 14 days.

- D. Correct low areas in unformed surfaces during or immediately after completion of surface finishing operations by cutting out low areas and replacing with fresh concrete. Finish repaired areas to blend into adjacent concrete. Proprietary patching compounds may be used when acceptable to Architect.
- E. Underlayment Application: Leveling of floors for subsequent finishes may be achieved by use of specified underlayment material.

### 3.10 QUALITY CONTROL TESTING DURING CONSTRUCTION

- A. The Contractor will employ a testing laboratory to perform the following tests, inspect formwork and reinforcement placement and to submit test reports.
- B. Sampling and testing for quality control during placement of concrete may include the following, as directed by Architect.
- C. Sampling Fresh Concrete: ASTM C 172, except modified for slump to comply with ASTM C 94.
  - 1. Slump: ASTM C 143; one test at point of discharge for each day's pour of each type of concrete; additional tests when concrete consistency seems to have changed.
  - 2. Air Content: ASTM C 173, volumetric method for lightweight or normal weight concrete; ASTM C 231 pressure method for normal weight concrete; one for each day's pour of each type of air-entrained concrete.
- D. Compression Test Specimen: ASTM C 31; one set of 4 standard cylinders for each compressive strength test, unless otherwise directed. Mold and store cylinders for laboratory cured test specimens except when field-cure test specimens are required.
- E. Compressive Strength Tests: ASTM C 39; one set for each day's pour exceeding 5 cu. yds. plus additional sets for each 50 cu. yds. over and above the first 25 cu. yds. of each concrete class placed in any one day; one specimen tested at 7 days, two specimens tested at 28 days, and one specimen retained in reserve for later testing if required.
- F. When frequency of testing will provide less than 5 strength tests for a given class of concrete, conduct testing from at least 5 randomly selected batches or from each batch if fewer than 5 are used.
- G. Test results will be reported in writing to Architect, Structural Engineer and Contractor within 24 hours after tests. Reports of compressive strength tests shall contain the project identification name and number, date of concrete placement, name of concrete testing service, concrete type and class, location of concrete batch in structure, design compressive strength at 28 days, concrete mix proportions and materials; compressive breaking strength and type of break for both 7-day tests and 28-day tests.
- H. Nondestructive Testing: Impact hammer, sonoscope or other nondestructive device may be permitted but shall not be used as the sole basis for acceptance or rejection.

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- I. Additional Tests: The testing service will make additional tests of in-place concrete when test results indicate specified concrete strengths and other characteristics have not been attained in the structure, as directed by Architect. Testing service may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C 42, or by other methods as directed. Contractor shall pay for such tests when unacceptable concrete is verified.

**END OF SECTION 03 30 00**

**SECTION 03 30 09 – UNDER-SLAB VAPOR BARRIER**

**PART 1 – GENERAL**

**1.1 SUMMARY**

**A. Products Supplied Under This Section**

1. Vapor Barrier, seam tape, mastic, pipe boots, detail strip for installation under concrete slabs.

**B. RELATED SECTIONS**

1. Section 03 30 00 Cast-in-Place Structural Concrete

**1.2 REFERENCES**

**A. American Society for Testing and Materials (ASTM)**

1. ASTM E 1745-97 (2004) Standard Specification for Plastic Water Vapor Retarders Used in Contact with Soil or Granular Fill Under Concrete Slabs
2. ASTM E 154-88 (2005) Standard Test Methods for Water Vapor Retarders Used in Contact with Earth Under Concrete Slabs
3. ASTM E 96-95 Standard Test Methods for Water Vapor Transmission of Materials
4. ASTM E 1643-98 (2005) Standard Practice for Installation of Water Vapor Retarders Used in Contact with Earth or Granular Fill Under Concrete Slabs

**B. American Concrete Institute (ACI)**

1. ACI 302.2R-06 Vapor Barrier Component (plastic membrane) is not less than 10 mils thick

**1.3 SUBMITTALS**

**A. Quality Control / Assurance**

1. Manufacturer's samples, literature
2. Manufacturer's installation instructions for placement, seaming and pipe boot installation

**1.4 SUBSTITUTIONS**

**A. Product Review**

1. Independent laboratory test results showing compliance with ASTM E 1745 (Class A) & ACI 302.2R-06 (less than 0.01 perms) standards. (Woven plastics are not permitted)

2. Request must be made 14 days prior to bid date to allow time for proper review.
3. Incomplete substitutions will not be accepted.

**PART 2 – PRODUCTS**

**2.1 MATERIALS**

A. Vapor Barrier: When the specifications of different sections conflict, the contractor shall perform to the most restrictive provision.

1. Vapor Barrier membrane must have the following properties.
  - a. Permeance rating Per ASTM E 96 or ASTM F 1249. Must meet permeance requirements for both the new material and following ASTM E-1745 mandatory conditioning tests (ASTM E 154; Sections 8, 11, 12, 13):
    - 1) New material                      Less than 0.01 perms (gr/ft<sup>2</sup>/hr/in-Hg)
    - 2) After conditioning                Less than 0.01 perms (gr/ft<sup>2</sup>/hr/in-Hg)
  - b. Water Vapor Barrier ASTM E 1745 Meets or exceeds Class A
  - c. Minimum thickness ACI 302.1R-06 10 mils
  - d. Basis of Design: Stego Wrap 15- mil Vapor Barrier by Stego Industries LLC
  - e. Other Acceptable Vapor Barrier Products:
    - 1) VaporGuard by Reef Industries, Inc
    - 2) Zero-Perm by Alumiseal
    - 3) W. R. Meadows: Perminator 10 mil.
    - 4) Or approved equal.

**2.2 ACCESSORIES**

- A. Seam Tape
  1. Tape must have the following qualities:
    - a. Water Vapor Transmission Rate ASTM E 96 0.3 perms or lower
  2. Seam Tape
    - a. Stego Tape by Stego Industries LLC
- B. Vapor Proofing Mastic
  1. Mastic must have the following qualities:
    - a. Water Vapor Transmission Rate ASTM E 96 0.3 perms or lower
  2. Mastic
    - a. Stego Mastic by Stego Industries LLC
- C. Pipe Boots

1. Construct pipe boots from vapor barrier material, pressure sensitive tape and/or mastic per manufacturer's instructions.

**PART 3 – EXECUTION**

**3.1 PREPARATION**

- A. Ensure that subsoil is approved by architect or geotechnical firm
  1. Level and tamp or roll aggregate, sand or tamped earth base.

**3.2 INSTALLATION**

- A. Install Vapor Barrier:
  1. Installation shall be in accordance with manufacturer's instructions and ASTM E 1643-98 (2005).
    - a. Unroll Vapor Barrier with the longest dimension parallel with the direction of the pour.
    - b. Lap Vapor Barrier over footings or seal to foundation walls.
    - c. Overlap joints 6 inches and seal with manufacturer's tape.
    - d. Seal all penetrations (including pipes) per manufacturer's instructions.
    - e. No penetration of the Vapor Barrier is allowed except for reinforcing steel and permanent utilities.
    - f. Repair damaged areas by cutting patches of Vapor Barrier, overlapping damaged area 6 inches and taping all four sides with tape.

**END OF SECTION 03 30 09**

**SECTION 03 45 00 - PRECAST ARCHITECTURAL CONCRETE**

**PART 1 - GENERAL**

1.1 SUMMARY

A. This Section includes the following:

1. Architectural precast concrete roof garden curb and/or slab units with aluminum railing inserts.
2. Architectural precast concrete sill.
3. Architectural precast exterior building benches.
4. Architectural precast site benches.

1.2 DEFINITION

A. Design Reference Sample: Sample of approved architectural precast concrete color, finish and texture, preapproved by Architect.

1.3 PERFORMANCE REQUIREMENTS

A. Structural Performance: Provide architectural precast concrete units and connections capable of withstanding the following design loads within limits and under conditions indicated:

1. Loads: As indicated.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated.

B. LEED Submittal:

1. Product Data for Credit MR 4.1 and Credit MR 4.2: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content.
  - a. Include statement indicating costs for each product having recycled content.

C. Design Mixtures: For each precast concrete mixture. Include compressive strength and water-absorption tests.

D. Shop Drawings: Detail fabrication and installation of architectural precast concrete units. Indicate locations, plans, elevations, dimensions, shapes, and cross sections of each unit. Indicate joints, reveals, and extent and location of each surface finish. Indicate details at building corners.

1. Comprehensive engineering analysis signed and sealed by the qualified professional engineer responsible for its preparation. Show governing panel / slab types, connections, and types of reinforcement, including special reinforcement. Indicate location, type, magnitude, and direction of loads imposed on the building structural frame from architectural precast concrete.

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- E. Samples: For each type of finish indicated on exposed surfaces of architectural precast concrete units, in sets of 3, illustrating full range of finish, color, and texture variations expected; approximately 12 by 12 by 2 inches.
  - F. Welding certificates.
  - G. Material test reports: For aggregates.
  - H. Material Certificates: Signed by manufacturers:
  - I. Field quality-control test and special inspection reports.
- 1.5 QUALITY ASSURANCE
- A. Fabricator Qualifications: A firm that assumes responsibility for engineering architectural precast concrete units to comply with performance requirements. This responsibility includes preparation of Shop Drawings and comprehensive engineering analysis by a qualified professional engineer.
    - 1. Participates in PCI's plant certification program at time of bidding and is designated a PCI-certified plant for Group A, Category A1 - Architectural Cladding and Load Bearing Units or participates in APA's "Plant Certification Program for Production of Architectural Precast Concrete Products" and is designated an APA-certified plant.
  - B. Design Standards: Comply with ACI 318 (ACI 318M) and design recommendations of PCI MNL 120, "PCI Design Handbook - Precast and Prestressed Concrete," applicable to types of architectural precast concrete units indicated.
  - C. Quality-Control Standard: For manufacturing procedures and testing requirements, quality-control recommendations, and dimensional tolerances for types of units required, comply with PCI MNL 117, "Manual for Quality Control for Plants and Production of Architectural Precast Concrete Products."
  - D. Welding: Qualify procedures and personnel according to AWS D1.1/D.1.1M, "Structural Welding Code - Steel"; and AWS D1.4, "Structural Welding Code - Reinforcing Steel."
  - E. Calculated Fire-Test-Response Characteristics: Where indicated, provide architectural precast concrete units whose fire resistance has been calculated according to ACI 216.1/TMS 0216.1, "Standard Method for Determining Fire Resistance of Concrete and Masonry Construction Assemblies," and is acceptable to authorities having jurisdiction.
  - F. Sample Panels: After sample approval and before fabricating architectural precast concrete units, produce a minimum of 2 sample panels approximately 4 sq. ft. in area for review by Architect. Incorporate full-scale details of architectural features, finishes, textures, and transitions in sample panels.

**PART 2 - PRODUCTS**

**2.1 REINFORCING MATERIALS**

- A. Recycled Content of Steel Products: Provide products with an average recycled content of steel products so postconsumer recycled content plus one-half of preconsumer recycled content is not less than 60 percent.
- B. Reinforcing Bars: ASTM A 615/A 615M, Grade 60 (Grade 420), deformed.
- C. Low-Alloy-Steel Reinforcing Bars: ASTM A 706/A 706M, deformed.
- D. Plain-Steel Welded Wire Reinforcement: ASTM A 185, fabricated from galvanized steel wire into flat sheets.
- E. Deformed-Steel Welded Wire Reinforcement: ASTM A 497/A 497M, flat sheet.
- F. Supports: Suspend reinforcement from back of mold or use bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded wire reinforcement in place according to PCI MNL 117.
- G. Prestressing Strand: ASTM A 416/A 416M, Grade 270 (Grade 1860), uncoated, 7-wire, low-relaxation strand.
  - 1. Coat unbonded post-tensioning strand with corrosion inhibitor passing ASTM D 1743 and sheath with polypropylene tendon sheathing. Include anchorage devices and coupler assemblies.

**2.2 CONCRETE MATERIALS**

- A. Portland Cement: ASTM C 150, Type I or Type III, gray, unless otherwise indicated.
  - 1. For surfaces exposed to view in finished structure, mix gray with white cement, of same type, brand, and mill source.
- B. Supplementary Cementitious Materials:
  - 1. Fly Ash: ASTM C 618, Class C or F, with maximum loss on ignition of 3 percent.
  - 2. Metakaolin Admixture: ASTM C 618, Class N.
  - 3. Silica Fume Admixture: ASTM C 1240, with optional chemical and physical requirement.
  - 4. Ground Granulated Blast-Furnace Slag: ASTM C 989, Grade 100 or 120.
- C. Normal-Weight Aggregates: Except as modified by PCI MNL 117, ASTM C 33, with coarse aggregates complying with Class 5S. Stockpile fine and coarse aggregates for each type of exposed finish from a single source (pit or quarry) for Project.
  - 1. Face-Mixture-Coarse Aggregates: Selected, hard, and durable; free of material that reacts with cement or causes staining; to match selected finish sample.
    - a. Gradation: Uniformly graded to match design reference sample.

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2. Face-Mixture-Fine Aggregates: Selected, natural or manufactured sand of same material as coarse aggregate, unless otherwise approved by Architect.
  - D. Coloring Admixture: ASTM C 979, synthetic or natural mineral-oxide pigments or colored water-reducing admixtures, temperature stable, and nonfading.
  - E. Air-Entraining Admixture: ASTM C 260, certified by manufacturer to be compatible with other required admixtures.
  - F. Chemical Admixtures: Certified by manufacturer to be compatible with other admixtures and to not contain calcium chloride, or more than 0.15 percent chloride ions or other salts by weight of admixture.
- 2.3 STEEL CONNECTION MATERIALS
- A. Carbon-Steel Shapes and Plates: ASTM A 36/A 36M.
  - B. Carbon-Steel Headed Studs: ASTM A 108, AISI 1018 through AISI 1020, cold finished, AWS D1.1/D1.1M, Type A or B, with arc shields and with minimum mechanical properties of PCI MNL 117, Table 3.2.3.
  - C. Carbon-Steel Plate: ASTM A 283/A 283M.
  - D. Malleable Iron Castings: ASTM A 47/A 47M.
  - E. Carbon-Steel Castings: ASTM A 27/A 27M, Grade 60-30 (Grade 415-205).
  - F. High-Strength, Low-Alloy Structural Steel: ASTM A 572/A 572M.
  - G. Carbon-Steel Structural Tubing: ASTM A 500, Grade B.
  - H. Wrought Carbon-Steel Bars: ASTM A 675/A 675M, Grade 65 (Grade 450).
  - I. Deformed-Steel Wire or Bar Anchors: ASTM A 496 or ASTM A 706/A 706M.
  - J. Carbon-Steel Bolts and Studs: ASTM A 307, Grade A (ASTM F 568M, Property Class 4.6); carbon-steel, hex-head bolts and studs; carbon-steel nuts, ASTM A 563 (ASTM A 563M); and flat, unhardened steel washers, ASTM F 844.
  - K. High-Strength Bolts and Nuts: ASTM A 325 (ASTM A 325M), Type 1, heavy hex steel structural bolts; heavy hex carbon-steel nuts, ASTM A 563 (ASTM A 563M); and hardened carbon-steel washers, ASTM F 436 (ASTM F 436M).
  - L. Zinc-Coated Finish: For exterior steel items and items indicated for galvanizing, apply zinc coating by hot-dip process according to ASTM A 123/A 123M or ASTM A 153/A 153M electrodeposition according to ASTM B 633, SC 3, Types 1 and 2.
    1. Galvanizing Repair Paint: High-zinc-dust-content paint with dry film containing not less than 94 percent zinc dust by weight, and complying with DOD-P-21035A or SSPC-Paint 20.

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- M. Shop-Primed Finish: Prepare surfaces of nongalvanized steel items, except those surfaces to be embedded in concrete, according to requirements in SSPC-SP 3 and shop-apply lead- and chromate-free, rust-inhibitive primer, complying with performance requirements in MPI 79 according to SSPC-PA 1.

2.4 GROUT MATERIALS

- A. Sand-Cement Grout: Portland cement, ASTM C 150, Type I, and clean, natural sand, ASTM C 144 or ASTM C 404. Mix at ratio of 1 part cement to 2-1/2 parts sand, by volume, with minimum water required for placement and hydration.
- B. Nonmetallic, Nonshrink Grout: Premixed, nonmetallic, noncorrosive, nonstaining grout containing selected silica sands, portland cement, shrinkage-compensating agents, plasticizing and water-reducing agents, complying with ASTM C 1107, Grade A for drypack and Grades B and C for flowable grout and of consistency suitable for application within a 30-minute working time.
- C. Epoxy-Resin Grout: Two-component, mineral-filled epoxy resin; ASTM C 881/C 881M, of type, grade, and class to suit requirements.

2.5 CONCRETE MIXTURES

- A. Prepare design mixtures for each type of precast concrete required.
  - 1. Limit use of fly ash and silica fume to 20 percent of portland cement by weight; limit metakaolin and silica fume to 10 percent of portland cement by weight.
- B. Design mixtures may be prepared by a qualified independent testing agency or by qualified precast plant personnel at architectural precast concrete fabricator's option.
- C. Limit water-soluble chloride ions to maximum percentage by weight of cement permitted by ACI 318 (ACI 318M) or PCI MNL 117 when tested according to ASTM C 1218/C 1218M.
- D. Normal-Weight Concrete Mixtures: Proportion mixtures by either laboratory trial batch or field test data methods according to ACI 211.1, with materials to be used on Project, to provide normal-weight concrete with the following properties:
  - 1. Compressive Strength (28 Days): 5000 psi (34.5 MPa) minimum.
- E. Water Absorption: 6 percent by weight or 14 percent by volume, tested according to PCI MNL 117.
- F. Add air-entraining admixture at manufacturer's prescribed rate to result in concrete at point of placement having an air content complying with PCI MNL 117.
- G. When included in design mixtures, add other admixtures to concrete mixtures according to manufacturer's written instructions.

2.6 FABRICATION

- A. Cast-in Anchors, Inserts, Plates, Angles, and Other Anchorage Hardware: Fabricate anchorage hardware with sufficient anchorage and embedment to comply with design requirements.

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Accurately position for attachment of loose hardware, and secure in place during precasting operations. Locate anchorage hardware where it does not affect position of main reinforcement or concrete placement.

1. Weld headed studs and deformed bar anchors used for anchorage according to AWS D1.1/D1.1M and AWS C5.4, "Recommended Practices for Stud Welding."
- B. Furnish loose hardware items including steel plates, clip angles, seat angles, anchors, dowels, cramps, hangers, and other hardware shapes for securing architectural precast concrete units to supporting and adjacent construction.
- C. Cast-in reglets, slots, holes, and other accessories in architectural precast concrete units as indicated on the Contract Drawings.
- D. Reinforcement: Comply with recommendations in PCI MNL 117 for fabricating, placing, and supporting reinforcement.
- E. Reinforce architectural precast concrete units to resist handling, transportation, and erection stresses.
- F. Prestress tendons for architectural precast concrete units by either pretensioning or post-tensioning methods. Comply with PCI MNL 117.
- G. Comply with requirements in PCI MNL 117 and requirements in this Section for measuring, mixing, transporting, and placing concrete. After concrete batching, no additional water may be added.
- H. Place face mixture to a minimum thickness after consolidation of the greater of 1 inch (25 mm) or 1.5 times the maximum aggregate size, but not less than the minimum reinforcing cover specified.
- I. Place concrete in a continuous operation to prevent seams or planes of weakness from forming in precast concrete units.
  1. Place backup concrete mixture to ensure bond with face-mixture concrete.
- J. Thoroughly consolidate placed concrete by internal and external vibration without dislocating or damaging reinforcement and built-in items, and minimize pour lines, honeycombing, or entrapped air on surfaces. Use equipment and procedures complying with PCI MNL 117.
  1. Place self-consolidating concrete without vibration according to PCI TR-6, "Interim Guidelines for the Use of Self-Consolidating Concrete in Precast/Prestressed Concrete Institute Member Plants."
- K. Comply with PCI MNL 117 for hot- and cold-weather concrete placement.
- L. Identify pickup points of architectural precast concrete units and orientation in structure with permanent markings, complying with markings indicated on Shop Drawings. Imprint or permanently mark casting date on each architectural precast concrete unit on a surface that will not show in finished structure.

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- M. Cure concrete, according to requirements in PCI MNL 117, by moisture retention without heat or by accelerated heat curing using low-pressure live steam or radiant heat and moisture. Cure units until compressive strength is high enough to ensure that stripping does not have an effect on performance or appearance of final product.
- N. Discard and replace architectural precast concrete units that do not comply with requirements, including structural, manufacturing tolerance, and appearance, unless repairs meet requirements in PCI MNL 117 and Architect's approval.

**2.7 FABRICATION TOLERANCES**

- A. Fabricate architectural precast concrete units straight and true to size and shape with exposed edges and corners precise and true so each finished panel complies with PCI MNL 117 product tolerances as well as position tolerances for cast-in items.

**2.8 FINISHES**

- A. Panel faces shall be free of joint marks, grain, and other obvious defects. Corners, including false joints shall be uniform, straight, and sharp. Finish exposed-face surfaces of architectural precast concrete units to match approved sample panels and as follows:
  - 1. PCI's "Architectural Precast Concrete - Color and Texture Selection Guide," of plate numbers indicated.
  - 2. As-Cast Surface Finish: Provide surfaces free of pockets, sand streaks, and honeycombs.
  - 3. Polished Finish: Use continuous mechanical abrasion with fine grit, followed by filling and rubbing procedures.
  - 4. Sand-Embedment Finish: Use selected stones placed in a sand bed in bottom of mold, with sand removed after curing.
- B. Finish exposed top, bottom and back surfaces of architectural precast concrete units to match face-surface finish.

**2.9 SOURCE QUALITY CONTROL**

- A. Quality-Control Testing: Test and inspect precast concrete according to PCI MNL 117 requirements. If using self-consolidating concrete, also test and inspect according to PCI TR-6, "Interim Guidelines for the Use of Self-Consolidating Concrete in Precast/Prestressed Concrete Institute Member Plants."
- B. Owner will employ an independent testing agency to evaluate architectural precast concrete fabricator's quality-control and testing methods.

**PART 3 - EXECUTION**

**3.1 INSTALLATION**

- A. Install clips, hangers, bearing pads, and other accessories required for connecting architectural precast concrete units to supporting members and backup materials.

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- B. Erect architectural precast concrete level, plumb, and square within specified allowable tolerances. Provide temporary supports and bracing as required to maintain position, stability, and alignment as units are being permanently connected.
  - 1. Maintain horizontal and vertical joint alignment and uniform joint width as erection progresses.
  - 2. Unless otherwise indicated, provide for uniform joint widths of 3/4 inch (19 mm).
- C. Connect architectural precast concrete units in position by bolting, welding, grouting, or as otherwise indicated on Shop Drawings. Remove temporary shims, wedges, and spacers as soon as practical after connecting and grouting are completed.
- D. Welding: Comply with applicable AWS D1.1/D1.1M and AWS D1.4 for welding, welding electrodes, appearance, quality of welds, and methods used in correcting welding work.
- E. At bolted connections, use lock washers, tack welding, or other approved means to prevent loosening of nuts after final adjustment.
- F. Grouting Connections: Grout connections where required or indicated. Retain grout in place until hard enough to support itself. Pack spaces with stiff grout material, tamping until voids are completely filled. Place grout to finish smooth, level, and plumb with adjacent concrete surfaces. Keep grouted joints damp for not less than 24 hours after initial set. Promptly remove grout material from exposed surfaces before it affects finishes or hardens.
- G. Erect architectural precast concrete units level, plumb, square, true, and in alignment without exceeding the noncumulative erection tolerances of PCI MNL 117, Appendix I.

**3.2 FIELD QUALITY CONTROL**

- A. Testing Agency: Owner will engage, if required, a qualified testing agency to perform tests and inspections and prepare test reports.
- B. Field welds will be subject to visual inspections and nondestructive testing according to ASTM E 165 or ASTM E 709. High-strength bolted connections will be subject to inspections.
- C. Testing agency will report test results promptly and in writing to Contractor and Architect.
- D. Repair or remove and replace work where tests and inspections indicate that it does not comply with specified requirements.
- E. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

**3.3 REPAIRS**

- A. Repair damaged architectural precast concrete units if permitted by Architect. The Architect reserves the right to reject repaired units that do not comply with requirements.

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- B. Mix patching materials and repair units so cured patches blend with color, texture, and uniformity of adjacent exposed surfaces and show no apparent line of demarcation between original and repaired work, when viewed in typical daylight illumination from a distance of 20 feet (6 m).
  - C. Prepare and repair damaged galvanized coatings with galvanizing repair paint according to ASTM A 780.
  - D. Wire brush, clean, and paint damaged prime-painted components with same type of shop primer.
  - E. Remove and replace damaged architectural precast concrete units when repairs do not comply with requirements.
- 3.4 CLEANING
- A. Clean surfaces of precast concrete units exposed to view.
  - B. Clean mortar, plaster, fireproofing, weld slag, and other deleterious material from concrete surfaces and adjacent materials immediately.
  - C. Clean exposed surfaces of precast concrete units after erection and completion of joint treatment to remove weld marks, other markings, dirt, and stains.
    - 1. Perform cleaning procedures, if necessary, according to precast concrete fabricator's recommendations. Clean soiled precast concrete surfaces with detergent and water, using stiff fiber brushes and sponges, and rinse with clean water. Protect other work from staining or damage due to cleaning operations.
    - 2. Do not use cleaning materials or processes that could change the appearance of exposed concrete finishes or damage adjacent materials.

**END OF SECTION 03 45 00**